

CLAIMS

I/We claim:

1. A method of preparing a sample for atom probe analysis, comprising:
positioning a surface of the sample with respect to a laser source;
directing laser energy from the laser source toward the surface to remove material from the sample, removing the material defining a recessed surface and leaving a projection of sample material projecting beyond the recessed surface;
reducing a lateral dimension of at least a portion of the projection to form a microtip having a reduced-dimension apex spaced from the recessed surface; and
juxtaposing the microtip with an electrode of an atomic probe.
2. The method of claim 1 wherein directing the laser energy comprises tracing a path in the material with the laser energy.
3. The method of claim 1 wherein the recessed surface extends laterally at least about 10 μm from a periphery of the projection.
4. The method of claim 1 wherein the projection is a first projection and removing material from the sample further defines a regular array of projections.
5. The method of claim 1 wherein the projection is a first projection and removing material from the sample further defines a second projection spaced from the first projection.

6. The method of claim 1 wherein the projection is a first projection, the microtip is a first microtip, and removing material from the sample further defines a second projection spaced from the first projection, the method further comprising reducing a lateral dimension of at least a portion of the second projection to yield a second microtip.
7. The method of claim 6 wherein the apex of the first microtip projects a first distance from the recessed surface and the apex of the second microtip projects a second distance from the recessed surface, the second distance being approximately equal to the first distance.
8. The method of claim 1 wherein removing the material from the sample comprises scribing an annulus about the projection with the laser energy, an outer end of the projection being approximately coplanar with a remaining portion of the sample surface.
9. The method of claim 1 wherein reducing the lateral dimension comprises etching the projection.
10. The method of claim 1 further comprising forming a reaction byproduct layer on the projection and reducing the lateral dimension comprises selectively removing the reaction byproduct layer.
11. The method of claim 1 wherein the sample comprises silicon and the method further comprises oxidizing the projection to form a silicon oxide (SiO_x) layer and reducing the lateral dimension comprises selectively etching the silicon oxide.
12. The method of claim 1 wherein reducing the lateral dimension comprises controlling an angle of incidence of the laser energy.

13. The method of claim 1 wherein reducing the lateral dimension comprises controlling an angle of incidence of the laser energy while removing the material to define the recessed surface.
14. The method of claim 1 further comprising inspecting the sample surface to identify an area of interest, wherein the material is removed from a location that is at least proximate the area of interest.
15. A method of analyzing a portion of a sample, comprising:
 - selectively removing material from the sample with laser energy to define an annulus about a sample column;
 - providing the sample column with a reduced-diameter apex at its outward end;
 - juxtaposing the apex with an electrode of an atom probe; and
 - with the apex juxtaposed with the electrode, controlling energy delivered to the apex to selectively remove material from the apex.
16. The method of claim 15 wherein selectively removing material to define the annulus comprises tracing a path in the material with the laser energy.
17. The method of claim 15 wherein the annulus has an inner dimension and an outer dimension that is greater than the inner dimension to define a transverse annulus width between the inner and outer dimensions of at least about 10 μm .
18. The method of claim 15 wherein the sample column is provided with the reduced-diameter apex by controlling an angle of incidence of the laser energy.

19. The method of claim 15 wherein the sample column is provided with the reduced-diameter apex by controlling an angle of incidence of the laser energy while selectively removing the material to define the annulus.
20. The method of claim 15 wherein the sample column is provided with the reduced-diameter apex by etching.
21. The method of claim 15 further comprising forming a reaction byproduct layer on the sample column, wherein the sample column is provided with the reduced-diameter apex by selectively removing the reaction byproduct layer.
22. The method of claim 15 wherein the sample comprises silicon and the method further comprises oxidizing the sample column to form a silicon oxide (SiO_x) layer, wherein the sample column is provided with the reduced-diameter apex by selectively etching the silicon oxide.
23. The method of claim 15 wherein the annulus is a first annulus, further comprising selectively removing a second annulus of material from the microelectronic component using the laser energy, the second annulus being spaced from the first annulus.
24. The method of claim 15 wherein the annulus is a first annulus and the sample column is a first sample column, further comprising selectively removing a second annulus of material from the microelectronic component using laser energy to define a second column, the second column being spaced from the first column.

25. The method of claim 24 further comprising providing the second sample column with a reduced-diameter apex substantially simultaneously with providing the first sample column with a reduced-diameter apex.
26. The method of claim 24 further comprising providing the second sample column with a reduced-diameter apex and, after juxtaposing the apex of the first sample column with the electrode, juxtaposing the apex of the second sample column with the electrode.
27. The method of claim 24 further comprising providing the second sample column with a reduced-diameter apex, the apexes being provided on the first and second sample columns by substantially simultaneously etching the first and second columns.
28. The method of claim 15 further comprising inspecting a surface of the sample to identify an area of interest, wherein the sample column is at least proximate the area of interest.
29. A method of analyzing a portion of a sample, comprising:
selectively removing material from the sample using laser energy to define an array of sample columns including a first sample column and a second sample column, the first sample column being spaced from the second sample column;
providing the first sample column with a reduced-diameter first apex at its outward end;
providing the second sample column with a reduced-diameter second apex at its outward end;
juxtaposing the first apex with an electrode of an atom probe; and

with the first apex juxtaposed with the electrode, controlling energy delivered to the first apex to selectively remove material from the first apex.

30. The method of claim 29 further comprising juxtaposing the second apex with the electrode and, with the second apex juxtaposed with the electrode, controlling energy delivered to the second apex to selectively remove material from the second apex.
31. The method of claim 29 wherein the removing material from the sample to define the array comprises removing a plurality of annuli including a first annulus and a second annulus, the first annulus circumscribing the first sample column and the second annulus circumscribing the second sample column.
32. The method of claim 29 wherein the first sample column is provided with the reduced-diameter apex by controlling an angle of incidence of the laser energy.
33. The method of claim 29 wherein the first sample column is provided with the reduced-diameter apex by controlling an angle of incidence of the laser energy while selectively removing the material to define the array.
34. The method of claim 29 wherein the first sample column is provided with the reduced-diameter apex by etching.
35. The method of claim 29 further comprising forming a reaction byproduct layer on the first sample column, wherein the first sample column is provided with the reduced-diameter apex by selectively removing the reaction byproduct layer.

36. The method of claim 29 wherein the sample comprises silicon and the method further comprises oxidizing the first sample column to form a silicon oxide (SiO_x) layer, wherein the first sample column is provided with the reduced-diameter apex by selectively etching the silicon oxide.
37. The method of claim 29 wherein the second sample column is provided with the second apex substantially simultaneously with providing the first sample column with the first apex.
38. The method of claim 29 wherein the first sample column is provided with the first apex and the second sample column is provided with the second apex by substantially simultaneously etching the first and second sample columns.
39. The method of claim 29 further comprising inspecting a surface of the sample to identify an area of interest, wherein the first sample column is at least proximate the area of interest.
40. A method of analyzing an area of interest of a sample, comprising:
identifying an area of interest on a surface of the sample;
directing laser energy toward the surface to remove material from the sample at least adjacent the area of interest, removing the material defining a recessed surface and leaving a projection of sample material at least adjacent the area of interest projecting beyond the recessed surface;
providing the projection with a reduced-diameter apex at its outward end;
and
juxtaposing the projection with an electrode of an atomic probe.

41. The method of claim 40 wherein directing the laser energy comprises tracing a path in the material with the laser energy.
42. The method of claim 40 wherein the recessed surface extends laterally at least about 10 μm from a periphery of the projection.
43. The method of claim 40 wherein the projection is a first projection and removing material from the sample further defines a regular array of projections.
44. The method of claim 40 wherein the projection is a first projection and removing material from the sample further defines a second projection spaced from the first projection.
45. The method of claim 44 further comprising providing the second projection with a reduced-diameter apex at its outward end.
46. The method of claim 45 wherein the apex of the first projection is spaced a first distance from the recessed surface and the apex of the second projection is spaced a second distance from the recessed surface, the second distance being approximately equal to the first distance.
47. The method of claim 40 wherein removing the material from the sample comprises scribing an annulus about the projection with the laser energy, an outer end of the projection being approximately coplanar with a remaining portion of the sample surface.
48. The method of claim 40 wherein providing the projection with the reduced-diameter apex comprises etching the projection.

49. The method of claim 40 further comprising forming a reaction byproduct layer on the projection and providing the projection with the reduced-diameter apex comprises selectively removing the reaction byproduct layer.
50. The method of claim 40 wherein the sample comprises silicon and the method further comprises oxidizing the projection to form a silicon oxide (SiO_x) layer and providing the projection with the reduced-diameter apex comprises selectively etching the silicon oxide.
51. The method of claim 40 wherein providing the projection with the reduced-diameter apex comprises controlling an angle of incidence of the laser energy.
52. The method of claim 40 wherein providing the projection with the reduced-diameter apex comprises controlling an angle of incidence of the laser energy while removing the material to define the recessed surface.